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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
10/021,881	12/14/2001	Linus Albert Fetter	37310-000175	2748

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EXAMINER	
CULBERT, ROBERTS P	

ART UNIT	PAPER NUMBER
1763	

DATE MAILED: 04/02/2004

Please find below and/or attached an Office communication concerning this application or proceeding.

Office Action Summary	Application No.	Applicant(s)	
	10/021,881	FETTER ET AL.	
	Examiner	Art Unit	
	Roberts Culbert	1763	

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If the period for reply specified above is less than thirty (30) days, a reply within the statutory minimum of thirty (30) days will be considered timely.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

1)☒ Responsive to communication(s) filed on *01 March 2004*.

2a)☒ This action is **FINAL**. 2b)☐ This action is non-final.

3)☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

4)☒ Claim(s) *1-5,7-12 and 14-29* is/are pending in the application.

4a) Of the above claim(s) *26-29* is/are withdrawn from consideration.

5)☐ Claim(s) _____ is/are allowed.

6)☒ Claim(s) *1-5,7-12 and 14-25* is/are rejected.

7)☐ Claim(s) _____ is/are objected to.

8)☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

9)☐ The specification is objected to by the Examiner.

10)☐ The drawing(s) filed on _____ is/are: a)☐ accepted or b)☐ objected to by the Examiner.

Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).

Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).

11)☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

Priority under 35 U.S.C. § 119

12)☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

a)☐ All b)☐ Some * c)☐ None of:

1.☐ Certified copies of the priority documents have been received.

2.☐ Certified copies of the priority documents have been received in Application No. _____.

3.☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

* See the attached detailed Office action for a list of the certified copies not received.

Attachment(s)

1) ☒ Notice of References Cited (PTO-892)
2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)
3) ☐ Information Disclosure Statement(s) (PTO-1449 or PTO/SB/08) Paper No(s)/Mail Date _____.
4) ☐ Interview Summary (PTO-413) Paper No(s)/Mail Date. _____ .
5) ☐ Notice of Informal Patent Application (PTO-152)
6) ☐ Other: _____.

DETAILED ACTION

Election/Restrictions

Newly submitted claims 26-29 are directed to an invention that is independent or distinct from the invention originally claimed for the following reasons:

The inventions of claims 1-25 and claims 26-29 are related as process of making and product made. The inventions are distinct if either or both of the following can be shown: (1) that the process as claimed can be used to make other and materially different product or (2) that the product as claimed can be made by another and materially different process (MPEP § 806.05(f)). In the instant case the product as claimed can be made by another and materially different process such as using dry etching instead of an etch bath to form the tapered electrode.

Since applicant has received an action on the merits for the originally presented invention, this invention has been constructively elected by original presentation for prosecution on the merits. Accordingly, claims 26-29 are withdrawn from consideration as being directed to a non-elected invention. See 37 CFR 1.142(b) and MPEP § 821.03.

Response to Arguments

Applicant's arguments filed 3/1/04 have been fully considered but they are not persuasive to overcome the rejections as explained below.

Applicant has argued that in the Lin reference, "*the range between 2 and 5 refers to an etching selectivity of a solution not to a ratio of relative etch rates of the first and second metal films*".

The argument is not persuasive because etch selectivity is defined by the etch rate of a target film divided by an etch rate of the reference film. The distinction made by applicant is not clear.

Applicant has argued, "*Nothing in Tsujimura or Lin teaches or suggests the forming of a desired angle taper based on the chemical compositions of a selected etch bath. Tsujimura is silent as to this*

feature. All that is known in Lin is that an etching solution used comprises H_3PO_4. HNO_3, or CH_3COH, to achieve a taper angle of about 7.5°"

The argument is not persuasive because Lin teaches forming a desired angle taper (7.5°) using a selected composition (H_3PO_4. HNO_3, or CH_3COH). The distinction made by applicant is not clear.

Applicant has argued that "*neither Tsujimura nor Krishnaswamy teach or suggest a method of forming a thin film resonator device comprising, at least: etching the first and second films using the etching mask to form the bottom electrode with a tapered edge, wherein the tapered edge is formed at a desired angle of taper that is based on a ratio of relative etch rates of the first and second films.*"

The argument is moot in view of the new grounds of rejection that follow that include the disclosure of Lin. Note that Lin was used in rejection of this limitation in the previous office action.

Applicant has argued that "*Further, with regard to Fig. 1a and Fig. 2a in Krishnaswamy, these figures explicitly shows the problems with the prior art, in which electrodes are formed with jointed or near-vertical steps as shown in each of prior art Fig. 1a and Fig. 2b of Krishnaswamy. Accordingly, deposition of a material such as the piezoelectric 25 and 26, for example in Fig. 2b would cause a film fracturing or discontinuity in the piezoelectric film, possibly leading to electrical discontinuities. This problem is solved by the present invention as recited in claim 8. For at least this additional reason, the rejection fails.*"

The argument is not persuasive because it is unclear how figures 1a and 2a of Krishnaswamy explicitly show electrodes formed with jointed or near-vertical steps, when it is clear from the drawings that the electrodes are in fact tapered. It is not clear how Fig. 2b of Krishnaswamy is relevant to applicant's discussion.

Applicant has argued that Tsujimura is non-analogous art in regards to claim 8. The argument is not persuasive because Tsujimura teaches a method for taper etching metal electrodes, which is entirely relevant to applicant's invention. Tsujimura mentions that the method is suitable for TFT or

semiconductors, which use metal, for example, aluminum wiring layers. There is nothing in Tsujimura to suggest that the invention is directed only at TFT devices.

Claim Rejections - 35 USC § 103

The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

> (a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negatived by the manner in which the invention was made.

This application currently names joint inventors. In considering patentability of the claims under 35 U.S.C. 103(a), the examiner presumes that the subject matter of the various claims was commonly owned at the time any inventions covered therein were made absent any evidence to the contrary. Applicant is advised of the obligation under 37 CFR 1.56 to point out the inventor and invention dates of each claim that was not commonly owned at the time a later invention was made in order for the examiner to consider the applicability of 35 U.S.C. 103(c) and potential 35 U.S.C. 102(e), (f) or (g) prior art under 35 U.S.C. 103(a).

Claims 1, 2 and 4, 5 and 15 are rejected under 35 U.S.C. 103(a) as being unpatentable over U.S. Patent 5,464,500 to Tsujimura et al. in view of U.S. Patent Application Publication 2002/0197875 to Lin et al.

Referring to Figures 7-10, Tsujimura teaches a prior art method of forming a film with a tapered edge in an electronic device, comprising: providing a substrate (11), forming a first film (13) on the substrate, forming a second film (14) on the first film, the first film having an etch rate that is different from an etch rate of the second film, forming an etching mask (15) on said second film, and etching the first and second films using the etching mask to form a resultant film having a tapered edge, wherein the second film is a disappearing mask layer for the first film, gradually exposing the first film to an etchant so as to produce a tapered edge which slopes to the substrate. See Figure 10.

Tsujimura teaches the method of the invention substantially as claimed, but does not explicitly teach that the angle of taper is controlled based on the relative etch rates of the first and second films.

Lin teaches that it is conventional in the art of forming tapered electrodes to form an upper metallic layer and a lower metallic layer where the etching rate of the upper metallic layer is greater than the etching rate of the lower metallic layer (Paragraph 16) and the angle of the etch may be controlled by selecting the metals (Paragraph 14) for the two layers and selecting the solution (Paragraph 15) for etch rate of the two layers. See also Paragraphs 3-7 and 17.

It would have been obvious to one of ordinary skill in the art at the time of invention to control the taper angle based on the relative etch rates of the first and second films as shown by Lin, as Lin teaches that the method is suitable for controlling the taper angle of an electrode using wet etching.

Note that one of ordinary skill in the art would have been further motivated at the time of invention to control the taper angle based on the relative etch rates of the first and second films in order to form a metal electrode with a low taper angle that can be deposited with an insulator having good step coverage. See Abstract of Lin.

Regarding claim 4, Tsujimura in view of Lin teaches the method of the invention substantially as claimed, but does not teach that the second film includes Ti.

Lin teaches that it is conventional in the art of forming tapered electrodes to form an upper metallic layer and a lower metallic layer where the etching rate of the upper metallic layer is greater than the etching rate of the lower metallic layer (Paragraph 16) and the metallic materials are selected from Cr, Al, Cu, Mo, Ta, or Ti. (Paragraph 14)

It would have been obvious to one of ordinary skill in the art at the time of invention to use Ti as the second layer instead of Mo as shown in Tsujimura, as Lin teaches that the two metals are equivalent for the purpose of forming a tapered electrode.

Regarding claim 5, Tsujimura further teaches that the etch rate of said second film is faster than the etch rate of said first film. (Col. 1, Lines 33-35)

Regarding claim 7, Tsujimura teaches that the resultant film after etching is the remaining first film. (See Figure 10)

Regarding Claim 15, in the invention of Lin, the desired angle of taper is based on the chemical composition of the etch bath. (Paragraph 15 and 16)

Claim 16-18 are rejected under 35 U.S.C. 103(a) as being unpatentable over U.S. Patent 5,464,500 to Tsujimura et al. in view of U.S. Patent Application Publication 2002/0197875 to Lin et al. as applied above, and in further view of U.S. Patent 3,919,066 to Maria Bertens.

As applied above, Tsujimura in view of Lin teaches the method of the invention substantially as claimed, but does not teach that the etch bath is a mixture of phosphoric, acetic and hydrochloric acids.

Maria Bertens teaches that the angle of a tapered aluminum layer may be adjusted by controlling the composition of an etching solution comprising hydrofluoric, acetic and phosphoric acids. (Col. 2, Lines 24-30)

It would have been obvious to one of ordinary skill in the art at the time of invention to use the composition of Maria Bertens to form a tapered aluminum electrode in order to enable control of the slope of the tapered aluminum electrode as taught by Maria Bertens, and permit good step coverage a taught by Lin.

Regarding Claims 17 and 18, Since Lin teaches that the ratio of the etch rates of the first and second films is between 2 and 5, and Maria Bertens provides a suitable etching composition for a tapered aluminum film, It would have been obvious to one of ordinary skill in the art at the time of invention as a matter of design choice to form the taper about 26° or 18° depending on the desired angle of taper.

Claims 3, 7, 8-12, 14, 19, and 23-25 are rejected under 35 U.S.C. 103(a) as being unpatentable over U.S. Patent 5,464,500 to Tsujimura et al in view of U.S. Patent Application

Publication 2002/0197875 to Lin et al, as applied above, and in further view of U.S. Patent 5,185,589 to Krishnaswamy et al.

Regarding claim 3, Tsujimura in view of Lin teaches the method of the invention substantially as claimed, but does not teach depositing at least one overlaying layer on the first film, the tapered edge ensuring that said at least one overlaying layer is continuous at a junction of the first film with the substrate.

Krishnaswamy teaches that it is conventional in the art of forming piezoelectric resonators to form a tapered aluminum electrode, deposit an overlying layer of piezoelectric material and then form another tapered aluminum electrode over the piezoelectric layer. (See Figures 1A and 2A, Col.1, Lines 18-22, and Col. 5, Lines 27-37) Krishnaswamy further shows that the tapered electrode edge ensures that the overlaying layer is continuous at a junction of the first film with the substrate. See Figures 1A and 2A.

It would have been obvious to one of ordinary skill in the art at the time of invention to form the tapered aluminum electrodes of Krishnaswamy using the tapered aluminum electrode forming technique of Tsujimura, the tapered electrode edge ensuring that said at least one overlaying layer is continuous at a junction of the first film with the substrate since Tsujimura teaches that the disclosed method is suitable for forming a tapered aluminum electrode using wet etching.

Regarding claim 7, Tsujimura teaches the method of the invention substantially as claimed, but does not teach that the first film is a formed bottom electrode of the electronic device.

Krishnaswamy teaches that it is conventional in the art of forming piezoelectric resonators to form a bottom tapered aluminum electrode, deposit an overlying layer of piezoelectric material and then form another top tapered aluminum electrode over the piezoelectric layer. (See Figures 1A and 2A, Col.1, Lines 18-22, and Col. 5, Lines 27-37)

It would have been obvious to one of ordinary skill in the art at the time of invention to form the bottom tapered aluminum electrode of Krishnaswamy using the tapered aluminum electrode forming technique of Tsujimura since Tsujimura teaches that the disclosed method is suitable for forming a tapered aluminum electrode using wet etching.

Regarding claims 8 and 23, Tsujimura in view of Lin teaches the method of the invention substantially as claimed, but does not teach that the first and second films are to be used to form a bottom electrode of the electronic device or the step of depositing a overlaying material on the formed electrode and forming a top electrode on said overlaying material by repeating the steps of providing a substrate, forming a first film on the substrate, forming a second film on the first film, the first film having an etch rate that is different from an etch rate of the second film, the first and second films to be used to form a bottom electrode of the electronic device, forming an etching mask on said second film, etching the first and second films using the etching mask to form the electrode with a tapered edge.

Krishnaswamy teaches that it is conventional in the art of forming piezoelectric resonators to form a tapered aluminum electrode, deposit an overlying layer of piezoelectric material and then form another tapered aluminum electrode over the piezoelectric layer. (See Figures 1A and 2A, Col.1, Lines 18-22, and Col. 5, Lines 27-37)

It would have been obvious to one of ordinary skill in the art at the time of invention to form the tapered aluminum electrodes of Krishnaswamy using the tapered aluminum electrode forming technique of Tsujimura since Tsujimura teaches that the disclosed method is suitable for forming a tapered aluminum electrode using wet etching. The benefits of wet etching techniques are well known in the etching art to include advantages such as low cost, reliability, high throughput and selectivity to mask and substrate.

Regarding Claims 19 and 24, in the invention of Lin, the desired angle of taper is based on the chemical composition of the etch bath. (Paragraph 15 and 16)

Claims 20-22 are rejected under 35 U.S.C. 103(a) as being unpatentable over U.S. Patent 5,464,500 to Tsujimura et al in view of U.S. Patent Application Publication 2002/0197875 to Lin et al, and U.S. Patent 5,185,589 to Krishnaswamy et al. as applied above, and in further view of U.S. Patent 3,919,066 to Maria Bertens.

As applied above, Tsujimura in view of Lin teaches the method of the invention substantially as claimed, but does not teach that the etch bath is a mixture of phosphoric, acetic and hydrochloric acids.

Maria Bertens teaches that the angle of a tapered aluminum layer may be adjusted by controlling the composition of an etching solution comprising hydrofluoric, acetic and phosphoric acids. (Col. 2, Lines 24-30)

It would have been obvious to one of ordinary skill in the art at the time of invention to use the composition of Maria Bertens to form a tapered aluminum electrode in order to enable control of the slope of the tapered aluminum electrode as taught by Maria Bertens, and permit good step coverage a taught by Lin.

Regarding Claims 21 and 22, Since Lin teaches that the ratio of the etch rates of the first and second films is between 2 and 5, and Maria Bertens provides a suitable etching composition for a tapered aluminum film, It would have been obvious to one of ordinary skill in the art at the time of invention as a matter of design choice to form the taper about 26° or 18° depending on the desired angle of taper.

Conclusion

The prior art made of record and not relied upon is considered pertinent to applicant's disclosure.

The Textbook Publication "*Etching in Microsystem Technology*" to Kohler teaches that it is old and well known in the art of etching to control taper angle based on the ratio of relative etch rates of the first and second films. (Page 19) Kohler also teaches that it is old and conventional to set the angle based on the composition and temperature of an etching bath. (Page 21)

Applicant's amendment necessitated the new ground(s) of rejection presented in this Office action. Accordingly, **THIS ACTION IS MADE FINAL**. See MPEP § 706.07(a). Applicant is reminded of the extension of time policy as set forth in 37 CFR 1.136(a).

A shortened statutory period for reply to this final action is set to expire THREE MONTHS from the mailing date of this action. In the event a first reply is filed within TWO MONTHS of the mailing date

of this final action and the advisory action is not mailed until after the end of the THREE-MONTH shortened statutory period, then the shortened statutory period will expire on the date the advisory action is mailed, and any extension fee pursuant to 37 CFR 1.136(a) will be calculated from the mailing date of the advisory action. In no event, however, will the statutory period for reply expire later than SIX MONTHS from the date of this final action.

Any inquiry concerning this communication or earlier communications from the examiner should be directed to Roberts Culbert whose telephone number is (571) 272-1433. The examiner can normally be reached on Monday-Friday (7:30-4:00).

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Gregory Mills can be reached on (571) 272-1439. The fax phone number for the organization where this application or proceeding is assigned is 703-872-9306.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see http://pair-direct.uspto.gov. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free).

R. Culbert R. Culbert

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AU 1763